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APPLICATION

FOR

UNITED STATES LETTERS PATENT

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

BE IT KNOWN, that We,

Yves Schabes, Boston, MA, and

Emmanuel Roche, Boston, MA,

have invented certain new and useful improvements in a **SYSTEM FOR ANSWERING NATURAL LANGUAGE QUESTIONS** of which the following is a specification:

System for Answering Natural Language Questions

This application claims the benefit of U.S. Provisional Application No. 60/200,766, filed April 28, 2000.

This application incorporates by reference in their entirety the contents of a computer program listing appendix containing six files created April 30, 2001, entitled "Example_Match_Input.txt" (19KB), "Example_Output.txt" (20KB), "frames.pm" (93KB), "frames.txt" (115KB), "makemap.pl" (33KB), and "match.pl" (41KB) submitted on two duplicate compact disks with this application.

Field of the Invention

The present invention relates to a system that processes a natural language question and provides an answer or answers to the question based on a body of information such as a collection of documents. The invention has particular utility in connection with text indexing and retrieval systems, such as retrieval of information from the World Wide Web.

Background of the Invention

Information retrieval systems are designed to store and retrieve information provided by publishers covering different subjects. Information retrieval engines are provided within prior art information retrieval systems in order to receive search queries from users and perform searches through the stored information. It is an object of most information retrieval systems to provide the user with all stored information relevant to the query. However, many existing searching/retrieval systems are not adapted to identify the best or most relevant information yielded by the query search. Such systems typically return query results to the user in such a way that the user must retrieve and view every document returned by the query in order to determine which document(s) is/are most relevant. For example, such a system may provide, in response to a natural language question, a mapping to other information sources or other questions the system considers

to be relevant or similar to the question the searcher asked, but not a straightforward answer to the natural language question. It is therefore desirable to have a document searching system which not only returns a list of relevant information to the user based on a query search, but also returns the information to the user in such a form that the user can readily identify which information returned from the search is most likely the answer to the question posed.

The quality of solutions to a query provided by an information retrieval system will depend, in part, upon the method utilized by the information retrieval system to determine the best match in a body of information such as a collection of documents, and also in part upon the form of the query received. Existing systems do not preanalyze the searched text, and therefore are required to conduct syntactic analysis each time a question is asked. Traditional search engines first identify a set of candidate documents in which relevant information may be found, and then read the identified documents in order to locate information. Such an approach suffers from two major drawbacks. First, it is time consuming because so many documents are typically retrieved, and because so much reading of documents to extract information is required. For example, queries issued on Internet search engines can retrieve thousands or even millions of documents. Second, although search engines try to rank documents from the most relevant to the least relevant, they do not perform an assessment of the results of the query across multiple documents.

An information retrieval system that allows a user to specify his or her query in the form they might ask the question naturally could potentially limit the over-inclusiveness of traditional keyword searching. Since, in traditional search systems, it is not possible to place any restrictions on the text between or around the search terms, a user is likely to encounter a great deal of material that is irrelevant to the actual information desired. On the other hand, an information retrieval system that allows matching to be conducted without strict ordering of query terms, and that linguistically analyzes the query and searched body of information, could potentially alleviate the under-inclusiveness of rigid, ordered keyword searching.

Summary of the Invention

In one aspect, the invention is a system (e.g., a method, an apparatus, and computer-executable process steps) for providing an answer to a natural language question. The invention accepts a natural language question and transforms the question into one or more partially unspecified queries. The system then identifies matches for the partially unspecified queries. A match for a query constitutes an answer to the question from which it is derived. In certain embodiments of the invention a plurality of answers is obtained and optionally ranked. Identifiers and/or locations for documents in which an answer is found may be returned in addition to or instead of the answer(s) themselves. The system is capable of answering questions in a number of formats, including some questions that are posed in a manner requiring a response in the affirmative or negative.

By automatically extracting information from documents, the system overcomes the limitations described above. First, the documents indexed are automatically analyzed by linguistic tools in anticipation of extracting information from the entire body of documents as a whole. Second, the inventive system accepts richer queries in which specific terms are used to identify the information requested in addition to search keywords. Third, the entire body of documents is treated as a unique source of information, and the inventive system returns in order of global frequency the actual answers that match the query instead of the list of documents that contain a match for the keywords of the query. The answers are collected across all documents which match the query, thus turning the overwhelming number of documents into an information source for computing the relevant information and returning one or more actual answers to the natural language question.

In other aspects, the invention is a contextual thesaurus and methods for using a contextual thesaurus to expand a question or statement into multiple equivalent questions or statements in which words or phrases are replaced by alternative words or phrases in a manner that preserves the meaning of the original text.

Brief Description of the Drawings

Figure 1 is a schematic diagram depicting the operating environment of the invention.

Figure 2 is flow diagram illustrating the overall process of obtaining an answer or answers for a natural language question.

Figure 3 is a flow diagram illustrating the process for obtaining matches for a set of partially unspecified queries that correspond to a natural language question.

Figure 4 is an illustration of an index data structure.

Figure 5 is an illustration of an example of a weighted finite state transducer.

Detailed Description

Preferred embodiments of the invention will now be described with reference to the accompanying drawings.

The invention may be implemented on a networked computer such as that shown in Figure 2 of Applicants' pending U.S. National Application titled "System for Fulfilling an Information Need", U.S. Serial No. 09/559,223, filed April 26, 2000 (hereinafter "the Information Need application"), the contents of which are hereby incorporated by reference in their entirety. Also incorporated in their entirety are the contents of Applicants' pending U.S. Provisional Application titled “System for Fulfilling an Information Need Using an Extended Matching Technique”, U.S. Serial No. 60/251,608, filed December 5, 2000 (hereinafter “the Extended Matching application”). The Extended Matching application builds upon the Information Need application, describing a technique for the identification of matches in documents in which the appearance of query terms are unordered or only partially specified with respect to the matches and in which there may be intervening words between the matching terms.

As described in the Information Need application and depicted in **Figure 1**, a searching site **2** comprising one or more query servers **4** and one or more indexing computers **6**, is logically connected (e.g., via the Internet) to one or more client computer systems **8**. Computers within searching site **2** may be connected to one another via a local area network, intranet, etc. A natural language question, may be entered into a

client system **8** by a user at a remote location and transmitted over the network to searching site **2**. The question may be processed at searching site **2**, and results for the question (e.g., one or more answers) transmitted to client system **8** for display to the user. Of course in certain embodiments of the invention questions can also be entered directly into query servers **4** at searching site **2**.

<u>Question Answering by Transforming Questions into Partially Unspecified Queries</u>

Applicants' pending Information Need application mentioned above provides a system for fulfilling an information need by providing a result for a partially unspecified query based on a body of information such as a collection of documents in a database (e.g., a collection of World Wide Web pages). As described therein, a partially unspecified query contains one or more unspecified terms. An unspecified term is generally represented by a special symbol such as an underscore character. In the present application an underscore is used to represent an unspecified term. An unspecified term can by wholly unspecified or partially unspecified. For example, the query

_ invented the telephone

contains a wholly unspecified term. A partially unspecified term is represented by a special symbol followed by a restriction. For example, the following query:

Agatha Christie was born _ [DATE]

contains a partially unspecified term with the restriction [DATE]. Applicants' applications mentioned above describe systems that identify matches for queries within a body of information such as documents in a database. The criteria for a match are defined in greater detail therein. Briefly, any term can match a wholly unspecified term. For a partially unspecified term, any term or group of terms that satisfies the restriction constitutes a match. Thus only a date will match the partially unspecified term _ [DATE] in the query above.

The structure of a partially unspecified query permits expression of a specific information need in a novel way. In contrast to traditional searching systems wherein a user specifies the term, perhaps accompanied by a delimiter, the Applicants' previously

mentioned applications allow the user to specify some feature of the information being sought. By finding matches for such a query the information need can be effectively fulfilled. In particular, by identifying a plurality of matches among a plurality of documents and then ranking the matches according to any of a variety of metrics (e.g., the number of times an instance of a match is located, or an indication of the reliability of a match), a user can be directed to those results that are more likely to be appropriate. Either the matches themselves, or portions thereof, can be returned as results for a query. Per the technique introduced in the Extended Matching application, the matching terms need not appear in the same relative order as in the query and there may be intervening words between the matching terms. Alternatively, the query terms may be partially or completely specified.

Although a system for providing results for a partially unspecified query considerably facilitates the task of retrieving information related to a specific need from a large body of information, it does not fully address a major goal in the field of information retrieval, namely providing answers to questions expressed in natural language. The present invention provides a system for and method of accomplishing this task. According to the present invention, a natural language question is transformed into one or more partially unspecified queries as described in more detail below. Matches are identified for the partially unspecified queries that correspond to the natural language question. In preferred embodiments of the invention, the portion of a match that corresponds to a partially unspecified term in the query is identified and/or stored. For the purposes of the present application, the portion of a match that corresponds to a partially unspecified term in a query, rather than the complete string that matches the query, will be referred to as a match. For example, one complete match for the query

Agatha Christie was born _ [DATE]

is the phrase *Agatha Christie was born in 1890*. For purposes of this application, the portion of this complete match that corresponds to (i.e., matches) the partially unspecified term _ [DATE] (in this case the date *in 1890*) constitutes a match for the query. In preferred embodiments of the invention a score is assigned to each match, and the

matches are ranked. In general, the processes of matching, assigning scores, and ranking matches for a partially unspecified query are performed as described in the Information Need application mentioned above. In the case that a question is transformed into multiple queries, the matches and their associated scores are appropriately combined, and the matches are ranked based on the combined score as described in more detail below. In a preferred embodiment of the invention, a ranked list of matches, or the match that receives the highest ranking, is returned as an answer to the question. The rationale for the inventive system relies on the existence of large bodies of information such as the set of World Wide Web pages or a subset thereof. Within such a large body of information, the likelihood that the answer to a question is present in the form of a corresponding statement is very high. Furthermore, it is likely that multiple instances of statements that constitute a potential answer for a question will exist within the body of information. Most such statements are likely to be accurate. Thus, by relying on the sheer volume of information available, and by ranking the identified answers (based, e.g., on frequency), the inventive system can effectively identify correct answers to a wide range of questions. For those ordered searches which fail to return a sufficient number of search results, the unordered query techniques of the Extended Matching application provides expanded search capabilities.

The processes of (1) transforming a natural language question into one or more partially unspecified queries; (2) identifying matches for the queries; (3) combining matches obtained for multiple queries; and (4) providing answers will now be discussed in further detail.

<u>Using Syntactic Frames to Identify Question Patterns within Linguistically Analyzed Questions</u>

Figures 2 and **3** illustrate an embodiment of the method of the present invention. **Figure 2** illustrates the steps by which a natural language question **110** is transformed into one or more partially unspecified queries **150**. The task of transforming natural language question **110** into one or more partially unspecified queries **150** can be

considered as a two-step process, in which natural language question **110** is first transformed into one or more corresponding partially unspecified statements **140** by statement generator **135**. The partially unspecified statements **140** are then transformed into the partially unspecified queries **150** by query generator **145**. With regard to the first transformation process, partially unspecified statements **140** that corresponds to natural language question **110** are statements that parallel, in structure, an answer to natural language question **110**. However, partially unspecified statements **140** do not in fact contain an appropriate answer to natural language question **110** but instead contains a word or words that reflects the item of information required to answer natural language question **110**. Such a word will be referred to herein as a question word. Note that in many instances there are numerous partially unspecified statements **140** that corresponds to a particular question. For example, the natural language question **110**

Who invented the telephone?

is transformed into the following partially unspecified statements **140**:

(1) *WHO invented the telephone*

(2) *The telephone was invented by WHO*

The question word *WHO* in the above partially unspecified statements **140** reflects the fact that an appropriate answer to natural language question **110** is the name of a human being. As another example, the natural language question **110**

When was Agatha Christie born?

is transformed to the following partially unspecified statement (among others):

Agatha Christie was born WHEN

The question word *WHEN* in the above partially unspecified statement **140** reflects the fact that an appropriate answer to natural language question **110** is a time adverbial such as a date. Referring to **Figure 2**, partially unspecified statements **140** are derived through the operation of statement generator **135** upon question patterns **130**. Question patterns **130** are derived through the operation of question matcher **125** upon analyzed question

120, during which question matcher **125** matches analyzed question **120** to a set of predetermined question patterns (contained in tables as described below). Question patterns **130** are those patterns that match. Analyzed question **120** is the output of question analyzer **115**, which takes as input natural language question **110** and subjects it to a syntactic and morphological analysis. The analysis assigns an appropriate combination of syntactic and/or morphological categories (e.g., noun phrase, verb phrase, verb tense) to various portions of natural language question **110**. Techniques for performing such textual analysis are known in the art and are described, for example, in Woods, W.A., *Transition Network Grammars for Natural Language Analysis*, Communications of the ACM, Vol. 13, No. 10, October, 1970; Roche, E., *Looking for Syntactic Patterns in Texts* in Papers in Computational Lexicography. Complex '92, Kiefer, F., Kiss, G., and Pajzs, J. (eds.) Linguistic Institute, Hungarian Academy of Sciences, Budapest, pp. 279-287; Karp, Schabes, Zaidel, and Egedi, *A Freely Available Wide Coverage Morphological Analyzer for English*, Proceedings of the 15th International Conference on Computational Linguistics, Nantes, pp. 950-954, 1992. The contents of the preceding references are hereby incorporated by reference in their entirety.

The partially unspecified statements **140** that correspond to particular question patterns **130** are equivalent in that they both have a structure corresponding to an appropriate answer to the question. By a simple mapping, statement generator **135** converts the question patterns **130** into the corresponding statement patterns **140**, which are expressed in terms of syntactic and/or morphological categories. Statement patterns **140** are provided to query generator **145**, which transforms them into one or more partially unspecified queries **150**. The operation of query generator **145** is described in more detail below. The queries are passed to matching module **155**, which identifies matches for the queries. The operation of matching module **155** is also described in more detail below and illustrate in **Figure 3**. The matches obtained by matching module **155** are provided as answers **260** to the question. In preferred embodiments of the invention, the matches are ranked and are output in an order based on the ranking. In certain

embodiments of the invention identifiers and/or locations of documents in which an answer is identified are also provided as part of the output.

The following examples illustrate the processes of question analyzer **115**, question matcher **125** which identifies appropriate question patterns **130**, statement generator **135** which generates partially unspecified statements **140**, and query generator **145** which transforms partially unspecified statements **140** into partially unspecified queries **150**. A natural language question **110** is analyzed and matched against a set of question patterns. The matching question pattern (or patterns) **130** is then transformed into one or more statement patterns **140**. The statement patterns **140** are then converted into query patterns, which are finally transformed into partially unspecified queries **150**. The examples provide representative answers obtained by the inventive method. The examples are distinguished by the form of question word associated with the natural language question **110**.

The Applicants have a working software application, which comprises an actual reduction to practice of the present invention. The software application employs three tables, *framemap1*, *framemap2*, and *adjframes* that are automatically generated from another table *FRAMES*. A *FRAME* is a set of phrases that have been derived through transformations to have different structure but the same informational content as a specific declarative sentence or an appropriate question word substituted in the phrase. The set of *FRAMES* presented at the end of the "Detailed Description" portion of the current application is not at all meant to be limiting, there are potentially many more *FRAMES* than included therein. Each non-question *FRAME* also includes *-A* and *-AH* adjunct modifiers/markers. These indicate the possible positions adjuncts can occur. *-A* represents any adjunct (time, manner, etc.), while *-AH* only represents manner. *-A* can be an appropriate position for an answer to a *WHEN* or *HOW* question. *-AH* can be an appropriate place of a response to a *HOW* question. *-AT* may also be used to designate a slot in which only a time adjunct modifier may appear. All the possible adjunct modifier positions are listed when a transformation is listed, but a process of the software application ensures that only one adjunct modifier position is possible at a time. The

typical contents of a *FRAME* are demonstrated by *FRAME 1*, which is comprised of the declarative sentence

the boy danced (-A NP0 -AH V -A)

and the possible set of grammatical transformations

WH0 V ?	*who danced?*
NP0 REL -AH V -A	*the boy who danced*
NP0 V(ing) -A	*the boy dancing*
DET A N0	*the dancing boy.*

Framemap1 is attached at the end of this "Detailed Description" section and comprises a table in which the key is of the form "WH NP V" and the associated value is of the form "WH1 NP0 V". This table is used to assign the proper numerical indexing to nouns and prepositions. The numerical indexes are necessary to keep track of corresponding nouns and prepositions which move as a frame rearranges into various phrase forms.

Framemap2 is attached at the end of this "Detailed Description" section and comprises a table which has keys in the form of "WH1 NP0 V". *Framemap2* returns an associated value of the form "NP0 V; NP0 REL V; NP0 V(ing)". The associated value lists all the possible transformations associated for that *FRAME*. *Framemap2* is used to derive all the possible transformations for a given *FRAME*. On the right side of each arrow in *framemap2* are all the potential affirmative statement structures which may be configured from a given query structure.

Adjframes is attached at the end of this "Detailed Description" section and comprises a table which has keys of the form "NP0 V" and associated values of the form "-A NP0 V; NP0 -AH V; NP0 V -A". This table is used to find the possible places adjuncts can be inserted into a given *FRAME*.

The foregoing examples use some or all of the following grammatical notations:

WH stands for question-word (who, what, whom, ...)

WHP stands for question-word phrase

AUX stands for any auxiliary verb (did, will, ...)

DATE stands for a time or date restriction

DET stands for a determiner (a, the, ...)

N stands for noun

NP stands for noun-phrase

V stands for verb, all possible forms

V-passive stands for verb in passive form

NHUM stands for a person's name restriction

REL stands for relative clause marker (who/which)

RELM stands for relative clause marker (whom/which)

-A stands for any type of adjunct

-AH stands for a manner-only adjunct

-AT stands for a time-only adjunct

? indicates the transformation is a question

# indicates the remainder of the line are comments

EX: indicates the entire line is a comment

WHO/WHAT QUESTIONS:

As a first example, consider the natural language question **110**

Who did the boy see?

Question analyzer **115** recognizes the word *Who* as a question word, the word *did* as auxiliary, *the* as a determiner, *boy* as a noun, *the boy* as a noun phrase, and *see* as a verb, in deriving analyzed question **120**

*(*WH who) (*AUX did) (*NP (*DET the) (*N boy)) (*V see)?*

Next, the analysis is simplified by ignoring all the question terms and auxiliary verbs and by ignoring the content of noun phrases to derive

WH NP V,

which is then looked up in table *framemap1* by question matcher **125** to find a corresponding numerically indexed phrase, or question pattern **130**, namely

WH1 NP0 V.

Next, in the step corresponding to the action of statement generator **135**, question pattern **130** is matched by look up into *framemap2* to obtain all possible transformations (within the quotes on the right side of the arrow, separated by semi colons) into affirmative statement patterns **140**:

"WH1 NP0 V" => "NPO V NP1; NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive0;NP1 REL V(Passive) BY NP0".

Since the question begins with *WH1* and it was a "who" question, all occurrences of a symbol followed by "1" are replaced by *NHUM*, the symbol standing for Noun Human:

NP0 V NHUM
NHUM REL NP0 V
NHUM NP0 V
NHUM V(PastP) BY NP0
NHUM V(PaSsive) BY NP0
NP0 REL NHUM V(Passive) BY
NP0 NHUM V(Passive) BY
NP0 BY RELM NP1 V(Passive)
NHUM REL V(Passive) BY NP0.

Next, query generator **145** transforms the statement patterns into partially unspecified queries **150** by replacing the question word with each of the appropriate restrictions (to form query patterns) and by then replacing the syntactic and/or morphological categories with the corresponding terms from the input natural language question **110**, resulting in

the boy saw [NHUM]
[NHUM] who the boy saw
[NHUM] the boy saw
[NHUM] seen by the boy
[NHUM] has been seen by the boy

the boy who [NHUM] was seen by

the boy [NHUM] was seen by

the boy by whom [NHUM] was seen

[NHUM] who was seen by the boy.

These resulting partially unspecified queries **150** are passed to matching module **155**, which performs the actual matching to obtain an answer to input question **110**.

WHERE/WHEN QUESTIONS

Assume the input natural language question **110** is

When did Bell invent the telephone?

Parser analysis yields

*(*WHEN when) (*AUX did) (*NP (*N Bell)) (*V invent) (*NP (*DET the) (*N telephone))?*

Then, as in the previous example, the analysis is simplified by ignoring then question words, all determiners, auxiliary verbs, and the content of noun phrases:

WHEN NP V NP.

Using *framemap1* (while ignoring *WHEN*) yields

NP V NP => NP0 V NP1,

and then *NP0 V NP1* is looked up into *framemap2* to obtain

NP0 V NP1 => NP0 V NP1; NP1 REL NP0 V; NP1 NP0 V; NP1 V(PastP) BY NP0; NP1 V(Passive) BY NP0; NP0 REL NP1 V(Passive) BY; NP0 NP1 V(Passive) BY; NP0 BY RELM NP1 V(Passive); NP1 REL V(Passive) BY NP0.

This step provides all possible *FRAMES*, or structural variants containing the same information, in which the sentence "Bell invented the telephone" can occur. Then each of those *FRAMES* are looked up into the *adjframes* table to determine where modifiers (temporal in this case) may be placed. For example, the first two *FRAMES* will yield:

NP0 V NP1 => *-A NP0 V NP1*

NP0 -AH V NP1

NP0 V -AH NP1

NP0 V NP1 -A

NP1 REL NP0 V => NP1 REL NP0 -AH V

NP1 REL NP0 V -A

Then the adjunct modifiers are adapted to the question, and the terms from the original natural language question **110** are reinserted to derive partially unspecified queries **150** as follows:

[DATE] Bell invented the telephone
Bell [DATE] invented the telephone
Bell invented [DATE] the telephone
Bell invented the telephone [DATE]
The telephone which Bell [DATE] invented
The telephone which Bell invented [DATE]

"HOW MANY" QUESTIONS

"How many Noun" questions are handled in a very similar fashion to "What" type questions. First, "how many noun" is replaced by "what" in the question. Then, the middle steps of the process are identical. The final step replaces "what" by "Number-Phrase Noun". For example, the natural language question **110**

How many novels did Agatha Christie write?

is transformed into partially unspecified query **150** (among others)

Agatha Christie wrote __[NUM] novels

which will match the following text

Agatha Christie wrote more than sixty novels.

and will give the following answer

More than sixty.

WHY QUESTIONS

WHY questions are handled very much like *WHEN* questions. First the word *WHY* is removed from a natural language question **110**. An affirmative question results from

this deletion. Then the transformations are applied and the positions of adjunct modifiers are looked up in the *adjframes* table. Finally, any adjunct modifier positions (*-A -AH*) are replaced by *WHY*. At query time, *WHY* should match expressions such as "*because* ___", "*in order to* ___".

HOW QUESTIONS

HOW questions are handled like *WHY* questions, in which *WHY* is replaced by *HOW*.

Transformation of Statement Patterns into Partially Unspecified Queries

The operation of query generator **145** will now be described in further detail. Query generator **145** receives statement patterns **140** as input and may access the contents of original natural language question **110**. Statement patterns **140** contain a question word and syntactic or morphological categories that correspond to elements in original natural language question **110**. In order to perform the transformation, in general, the question word is replaced by a partially unspecified term having a restriction that corresponds to the question word. Briefly, transformation of an affirmative statement into a partially unspecified query **150** involves a mapping between a question word or words (or the equivalent) and one or more appropriate partially unspecified term(s). The particular mapping will vary depending upon the specific restrictions associated with partially unspecified terms that are employed in any given implementation of the inventive system. The table below presents a partial mapping of question words (left column) to partially unspecified terms associated with appropriate restrictions (middle column). The column on the right provides a brief explanation of the restrictions.

Question word	Unspecified query	Explanation
Who	_[NHUM]	Human name

What	_[NP]	Noun phrase
What	_[LOCATION]	Location
Where	_[LOCATION]	Location
When	_[DATE]	Date
When	_[TIME]	Time
How many	_[NUMBER]	Number
At what time	_[TIME]	Time
In which nation	_[LOCATION]	Location
How ADJECTIVE	_[MEASURE]	Unit of measure

It will be appreciated that in preferred embodiments of the invention, additional restrictions are employed in order to be able to perform appropriate mappings for as wide a variety of questions as possible. Query generator **145** identifies the restrictions to which a question word in an input statement maps, and replaces the question word in the input statement with each such restriction. For example, the question word *WHEN* maps to the restriction _ [DATE] and _[TIME]. Therefore, in a partially unspecified statement **140** in which the question word *WHEN* appears, the word *WHEN* is replaced with the restriction _ [DATE] to form one partially unspecified query **150** and with the restriction [TIME] to form a second partially unspecified query **150**. Thus a *WHEN* question is transformed into at least two queries since *WHEN* maps to two restrictions.

The second aspect of transforming a statement pattern **140** into a partially unspecified query **150** involves replacing the generic syntactic and/or morphological categories in the statement patterns **140** with the corresponding elements from input natural language question **110**. This process may involve operating on certain words in input question **110** in order to derive the appropriate form or ordering of words with which to replace the syntactic and/or morphological categories. Such operations are performed in a standard manner as described in the references to textual analysis mentioned above.

For purposes of description, the transformation of a natural language statement **110** into a partially unspecified query **150** has been presented overall as a two step process in which the question is first transformed into a statement having a question word and the statement is then transformed into a partially unspecified query. However, it is to be understood that the process may take place in a single step. The discussion above describes the overall operations performed by the inventive system but are not intended to be limiting in anyway. In particular, the discrete steps described above may be combined and may be distributed among various modules of code (i.e., computer-executable process steps) in any of a variety of ways. The system may also be extended to languages other than English in accordance with the grammatical rules of such languages, and answers to questions in a non-English language can be obtained by identifying matches within a body of information expressed in the particular language of the question.

<u>Identifying Matches for Partially Unspecified Queries and Providing Answers</u>

A flow diagram showing the operation of matching module **155** in a preferred embodiment of the invention is presented in **Figure 3**. In brief, matching module **155** operates on partially unspecified queries **150** to obtain a global match list, which includes matches for all of the queries, which (as described above) are equally weighted for the present purposes. In step **205**, matching module **155** receives a set of partially unspecified queries **150** corresponding to an input natural language question **110**. In step **210**, the global match list GM is initialized to be empty. In step **215**, a partially unspecified query Q from the set of partially unspecified queries **150** is selected. At decision point **220**, if a query is found, processing proceeds to step **225** in which matches for the query are identified. A match list M (with associated scores for the matches) for Q is assembled. Methods for identifying matches and assigning a score to a match are fully described in the Information Need application mentioned above. Briefly, the score reflects the occurrence of a match among a plurality of documents. At decision point **230**, if the match list M for Q is non-empty (i.e., if matches for Q were identified in the

preceding step), the matches in M are added to global match list GM in step **235**. Control then passes to decision point **240**. If more matches are needed (which can be determined according to any of a variety of criteria such as those described in the Information Need application), then processing returns to step **215**, in which a different partially unspecified query is selected from the set of partially unspecified queries **150**. If, on the other hand, no more matches are needed, processing proceeds to step **245** in which the global match list GM is processed as described below. Returning to decision point **230**, if match list M is empty (i.e., no matches were found for query Q), processing goes directly to step **240** and proceeds as described above.

Returning to step **245**, it will be appreciated that the same match may be identified as a match for multiple partially unspecified queries. Each such match will have its own associated score in each match list M corresponding to a query for which the match was identified. Processing of global match list GM entails combining the matches and associated scores obtained as results for the individual queries to obtain a combined score for each distinct match. For example, if match A appears in match list M_1 with a score of X, and match A also appears in match list M_2 with a score of Y, then in the processed global match list match GM A appears with a combined score of X + Y. Note that processing of the global match list GM may alternatively take place as the matches for individual queries are identified. However, for purposes of illustration it is described herein as occurring in a separate step.

Step **250** in preferred embodiments of the invention involves ranking the matches in global match list GM based on the scores. This step is optional, but by ranking the matches the likelihood that correct answers to the question will be presented before incorrect answers will be maximized. In step **260**, the answers are presented along with optional information such as the rank, combined score, and/or identifiers or locations for documents in which the answers were identified.

Although for purposes of illustration the examples above have presented cases in which only a single match is found for a partially unspecified query, in accordance with the present invention a plurality of distinct matches may be identified. Furthermore,

multiple instances of one or more of the matches may be identified. In accordance with the invention, as described above, a plurality of distinct matches may be identified as an answer to the question. Preferably the matches are ranked. In certain embodiments of the invention a score is assigned to the matches, the score preferably reflecting the number of times an instance of the match is identified.

The Information Need application fully describes using a set of contexts created from documents in a database corresponding to strings containing given terms found in the documents. In certain preferred embodiments, the contexts are stored as finite state automata. The inventive system locates matches for the query within the set of contexts rather than searching for matches within the documents themselves, thereby providing an opportunity for faster and more efficient processing of the query. As the system locates matches among the contexts it also accumulates information related to the matches, which may used to rank the located matches. Additionally, in addition to storing the contexts themselves, in certain embodiments information about the contexts is also stored, such as the position of the context within the document, the age of the document in which the context appears, or the co-occurrence of certain words within the context. In certain preferred embodiments, for a given term, not only are the words constituting the context stored, but also analyses of the sequence of those words.

Note that either an entire match, or a portion thereof that corresponds to a partially unspecified term can be provided as an answer. For example, the name *Alexander Graham Bell* rather than a complete sentence such as *Alexander Graham Bell invented the telephone* can be provided, or the date *1890* rather than a complete sentence such as *Agatha Christie was born in 1890* can be provided. In certain embodiments of the invention, only one or a subset of identified answers are provided as an answer to a question. For example, if the great majority of located matches are instances of a particular match M, then it is likely that match M represents a correct answer to the question. In such a case it may be desirable to present only that answer rather than additional answers that are much less likely to be correct. In addition to providing an answer or answers to a question, in certain embodiments of the invention, document

identifiers or locations for the documents that contain the answer may be presented with the answer.

The following sections of the application present additional aspects of the invention in certain preferred embodiments.

Question Answering with Extended Matching Techniques

As described in the Applicant's Extended Matching application, the techniques described above will solve many types of natural language questions, however there may be questions for which the techniques described above do not result in enough matches to create a high level of confidence in the answer(s). In such situations, it may be necessary to employ the search and matching techniques described in the Extended Matching application. Such situation may arise when, for example, there are superfluous words between the search terms of potential matches in the text being searched (e.g., *Bell* *apparently* *invented the telephone.*) The techniques will be only briefly discussed here, as they are described in detail in the Extended Matching application, which has been incorporated by reference herein. The Extended Matching application describes three methods for implementing unordered queries: using a simple extension of the technique of the Information Need application of storing contexts associated with document words without additional data structures; encoding a query using a finite state transducer in which all possible orderings of the query are represented, and using weights assigned to arcs of the finite state transducer to accumulate a score for a match that reflects the difference(s) between the query and the matching context; and using a new index structure identifying terms within documents that satisfy restrictions associated with partially unspecified terms, and intersecting document lists to identify matches.

Briefly, the techniques allow for an unspecified order among the matches of the wholly specified and partially unspecified terms of the query. For example, consider partially unspecified query

Senate [ADDRESS].

The partially unspecified query in extended matching will match addresses found in documents in which the word *Senate* occurs, regardless whether they occur in order or adjacent to each other.

The second method described in the Extended Matching application involves encoding all possible orders of a query with a finite state machine/transducer. **Figure 5** illustrates a finite state machine/transducer which represents all possible orders of "*invented the telephone*" with an additive score associated with each arc. The scores on each arc are added to form a score of the strings (0 being a perfect order, 1 having a single permutation, etc…). All possible orders of a query are encoded into one single finite state transducer. **Figure 5** does not include intervening words, but this may be addressed by adding loops (arcs originating from and arriving at the same state) matching any word on each state of the transducer. Partially unspecified terms may also be included in the finite state transducer. For each context selected by the method described in the Information Need application, the finite state transducer is matched against the context, and if the match is successful, matches of partially unspecified terms are collected and scored using the weights on the arcs.

In the third method, first the documents are analyzed in order to identify various sorts of linguistic entities such as person names, company names, phone numbers, addresses, and noun phrases. Then, an index comprised of the following data structure is built from the output of the analysis:

- For each word appearing in the documents, a list of document identifiers in which the word appears is associated; and
- For each concept extracted during linguistic analysis (such as person names, phone numbers, …), a list of document identifiers are each associated with the strings which match the concept in the associated documents is built. (**Figure 4** illustrates the data structures.)

Referring back to the example, comprised of one partially specified term *[ADDRESS]* and one fully specified term *Senate*. Both the list of document identifiers corresponding to the specified term, and the list of document identifiers with the associated strings

corresponding to the partially specified term are extracted. Then, the system proceeds to intersect the sets of documents found in the two lists while collecting the strings for the documents found in both lists. This process may be easily extended to an arbitrary number of query search terms.

Extended matching may also solve ordered queries, i.e. queries in which some terms in the queries must appear adjacent to one another. A convention has been adopted in the Extended Matching application of identifying such terms by enclosing such terms in double quotes. For example, the query

"[FIRSTNAME] Clinton"

will extract all the names (such as *Hillary, Bill* and *Chelsea*) which immediately precede the word *Clinton* in the documents.

The previous implementation can be easily combined to form queries in which some terms must be in a precise order, and others may appear in any order. For example, the query

"[FIRSTNAME] Gates" [COMPANY]

will result in first names immediately preceding the word *Gates* and the company names which occur before or after the string *"FIRSTNAME Gates"*. Boolean operators can also be easily added to the query.

In another embodiment, the invention employs an extended parsing technique by which a natural language question such as

who did invent the omnipresent telephone? has terms which are considered important extracted, generating a partially unspecified statement

who invent telephone.

Then this partially unspecified statement is run through the extended matching technique. This approach allows the inventive system to handle questions not otherwise answerable.

Use of Thesaurus

In certain preferred embodiments of the invention, in order to collect more answers for a natural language question **110**, a thesaurus is used to rephrase the natural

language question **110**, the partially unspecified statement(s) **140** corresponding to natural language question **110**, or the set of partially unspecified queries **150** corresponding to natural language question **110** using words, phrases, or expressions that are synonyms of portions therein. The rephrasing is accomplished by substitution of equivalent words or phrases from previously defined tables similar to the *FRAMES* described earlier..

For example, in the query

Where are Arabian horses are bought?

The verb *purchased* could be used instead of the verb *bought.* Thus, using dictionaries of synonyms of words and expressions, the invention will transform the previous question into the following partially unspecified queries (among others):

Arabian horses are bought _ [LOCATION]

Arabian horses are purchased _ [LOCATION]

The answers of each of these partially unspecified queries **150** are combined to form one single set of answers by combining the score and counts of each query and ranking the answers based upon the combined score.

One aspect the present invention comprises a contextual thesaurus that is useful for expanding the set of statements and corresponding queries for a natural language question **110**. In contrast to a traditional thesaurus, which presents synonyms for words, phrases, etc. independent of context, the contextual thesaurus of the present invention takes context into consideration in offering appropriate replacements for words or phrases within statements or queries. Briefly, the contextual thesaurus utilizes a syntactic and morphological analysis (performed as described in the references mentioned above) of an input question or statement and then suggests appropriate equivalent words or phrases that may be used to replace words or phrases in the input question or statement while preserving the meaning of the question or statement. In effect, the contextual thesaurus selects from among all possible synonyms as would appear in a traditional thesaurus,

those that are appropriate given a particular context. The contextual thesaurus may be used independently of the question and statement transformation aspects and the matching aspects of the present invention. Although the contextual thesaurus is particularly helpful in the setting of the present invention, it may of course be used in a wide variety of other applications. The nature of the contextual thesaurus is illustrated by the following two examples, which discuss compound nouns and adjectives.

Example One - Compound Noun

In a traditional thesaurus, synonyms for the noun *battle* include the words *fight* and *combat*. However, although equivalent in some situations, these words are not interchangeable in all contexts. Thus for the phrase *battle plan*, the word *combat* is a contextually appropriate synonym for the word *battle*, since the phrase *combat plan* is grammatically and logically correct. However, the word *fight* is not a contextually appropriate synonym for the word *battle* since the phrase *fight plan* is unacceptable according to normal English usage. Thus if the phrase battle plan appears in a question or statement, the contextual thesaurus allows the generation of additional equivalent queries or statements in which the phrase *battle plan* is replaced by *combat plan* but avoids generating contexually inappropriate phrases in which *battle plan* is replace by *fight plan*.

Example Two - Adjectives

It will be appreciated that adjectives may have different meanings depending upon context. A partial set of synonyms for the adjective *bright* may include the words *clever*, *intelligent*, *smart*, *gifted*, *sharp*, *luminous*, *intense*, *vivid*, etc. However, only the first five of these is appropriately applied to an animate being or an idea, as in *bright man, clever man, intelligent man,* etc. The final three are appropriately applied to a color or to a light as in *bright color, intense color*. By taking context into consideration, the contextual thesaurus recognizes that if the adjective *bright* precedes an animate being or an idea (among others), then appropriate synonyms include the first five words listed

above but not the final three. On the other hand, if the adjective *bright* precedes the word *color* or the word *light*, the contextual thesaurus recognizes that appropriate synonyms include the final three words in the list above but not the first five.

As illustrated by the examples above, by taking context into consideration, the contextual thesaurus allows the selection, from among all synonyms for a word or phase considered without respect to context, those that are acceptable according to normal usage. Of course the contextual thesaurus is not limited to the examples described above.

Yes/No Questions

The questions presented above are characterized in that they contain an identifiable question word. However, in preferred embodiments, the present invention also provides methods for answering yes/no questions, i.e., questions that may be answered with "yes" or "no" answer.

Yes/no questions may be answered by a positive or a negative statement. For example,

Did Alexander Graham Bell invent the telephone?

is a yes/no question since its answer is *yes*. The system is able to answer yes/no questions by first transforming a yes/no question to a regular question (i.e., defined herein as a question that includes a question word) and then finding an answer to the regular question. If no answer is found using the previously described technique, a negative answer (no) is given to the yes/no question. If one or more answers are found, a positive answer (yes) is given to the yes/no question.

Certain types of yes/no questions are matched against a set of yes/no templates that transform a yes/no question to a regular question. The templates may then be mapped to partially unspecified queries as described above. The following examples illustrate the technique.

Example One

Yes-No Question: Do you know who invented the telephone?

Question Template: Do you know QUESTION

Regular Question: QUESTION

The queries corresponding to QUESTION are issued. In other words, the queries corresponding to

Who invented the telephone?

are issued.

Example Two

Yes-No Question: Can you tell me who invented the telephone?

Question Template: Can you tell me QUESTION

Regular Question: QUESTION

The queries corresponding to QUESTION are issued. In other words, the queries corresponding to

Who invented the telephone?

are issued.

Other types of yes/no questions are handled by isolating a statement that occurs within the question. The statement is then transformed into an appropriate query. Matches are identified for the queries. If matches are found, this indicates that the correct answer to the question is "yes". If no matches are found this indicates that the answer is "no". Note that these queries are fully specified, but the matching process nevertheless proceeds as described. This method for handling yes/no questions is illustrated in the following example.

Example Three

Yes/No Question: Did Alexander Graham Bell invent the telephone?

Question Template: Did STATEMENT?

Statement: STATEMENT

Queries: Alexander Graham Bell invented the telephone

the telephone was invented by Alexander Graham Bell

Since the present invention relies on answers to partially unspecified queries or matches for fully specified queries for the yes/no answer, in addition to giving a positive or negative answer to a yes/no question, the present invention also presents evidence for the positive statements in the form of answers for the corresponding partially unspecified queries. In other words, the existence of matches for the corresponding partially unspecified queries (which can be displayed to a user) serves as validation of a positive answer.

Additional Search and Matching Technique

It is to be understood that the invention is not limited to operating on simple questions such as those presented above or on questions that contain a clearly identifiable question word. Instead, the invention encompasses the use of partially unspecified queries in conjunction with the matching approach described herein to answer a wide variety of natural language questions **110**.

As previously described, an early step in the method of the current invention is to linguistically analyze the text to be searched, in order to categorize terms and phrases where possible. It is not always possible to categorize every word or phrase in the text through syntactic analysis. For example, consider the natural language question **110**

Which Red Sox pitcher won the Cy Young Award?

and assume that a list of all *Red Sox pitchers* has not been previously generated. It is desirable to recognize how *Pedro Martinez* is associated with *Red Sox pitcher*. More complex questions such as this one may be answered, in a preferred embodiment, by dividing the natural language question **110** up into two or more indirectly-linked, yet separately matchable partially unspecified queries **150**, and comparing the resulting match lists. This may be accomplished sequentially or in parallel. In the sequential approach, a first step would be to solve an initial query

WHO Red Sox pitcher?

derived from natural language question **110** in order to obtain a match list of all *Red Sox pitchers*, such as

name1 = Hideo Nomo,

name2 = Pedro Martinez, etc.

Next, the match list results would be inserting into the remainder of natural language question **110**, and the resulting statements used to match possible answers. For example, the insertions would result in

name1 won the Cy Young Award? => Hideo Nomo won the Cy Young Award?

name2 won the Cy Young Award? => Pedro Martinez won the Cy Young Award?.

And the statements on the right side of the arrows would be used in an attempt to match correct answers.

The method could also be performed in parallel. Two queries could be conducted in parallel:

Who Red Sox pitcher?	results in name1, ...
Who won the Cy Young Award?	results in name2, ...

and in the next step the match list resulting from each of the separate queries could be compared to obtain an answer, that is, does

name1 = name2.

This powerful technique allows for the answering of more complex questions in which the relation or association between different terms within the question is not immediately evident.

<u>Working Model of the Invention</u>

The computer program listing appendix contains the following files:

"frames.pm" is a PERL module file needed for program file "match.pl", which contains tables *framemap1, framemap2,* and *adjframes*;

"frames.txt" is the *FRAMES* text file that is written by hand;

"makemap.pl" is a PERL program which automatically generates the tables *framemap1, framemap2* and *adjframes* from the input file "frames.txt";

"match.pl" is a PERL program which takes as input an analyzed question and produces partially unspecified statements using file frames.pm; and

"Example_Match_Input.txt" and "Example_Output.txt" are, respectively, an example input file to the program "match.pl" and the corresponding output.

Below are the listings of tables *FRAMES*, *framemap1*, *framemap2*, and *adjframes* referred to earlier in the application. The *FRAMES* table uses the following annotations:

```
#   = rest of line is comments
EX:  = entire line is comment
FRAME 1 = all the following lines are part of the same frame, until
          another FRAME line, end of file, or ### STOP line.  The
          numbering does not have to be consecutive.

FRAME 1
    ## EX: the boy danced
    -A NP0 -AH V -A

    WH0 V ?                 ## who danced?
    NP0 REL -AH V -A        ## the boy who danced
    NPO V(ing) -A           ## the boy dancing
    ## Det A N0             ## the dancing boy

FRAME 2
    EX: The boy fell down.
    -A NP0 V -AH P1 -A

    WH0 V P1 ?              ## who fell down?
    NP0 REL -AH  V P1 -A    ## the boy who fell down
    NP0 -AH V(ing) P1 -A    ## the boy falling down

FRAME 3
    EX: the boy saw the girl.
```

```
-A NP0 -AH V -AH NP1 -A

WH0 V NP1 ?                           ## Who saw the girl?
WH1 NP0 V ?                           ## who did the boy see?
NP1 REL NP0 -AH V -A                  ## the girl who the boy saw
NP1 NP0 -AH V -A                      ## the girl the boy saw
NP1 V(PastP) -A BY NP0 -A             ## the girl seen by the boy
NP1 V(Passive) -A BY NP0 -A           ## the girl was seen by the boy
BY WH0 NP1 V(Passive) ?               ## by whom was the girl seen?
WH0 NP1 V(Passive) BY ?               ## who was the girl seen by?
WH1 V(Passive) BY NP0 ?               ## Who was seen by the boy?
NP0 REL -A NP1 V(Passive) BY -A       ## the boy who the girl was seen by
NP0 NP1 V(Passive) BY -A              ## the boy the girl was seen by
NP0 BY RELM NP1 V(Passive) -A         ## the boy by whom the girl was
                                      seen
NP1 REL -AH V(Passive) BY NP0 -A      ## the girl who was seen by the boy
```

FRAME 4

```
EX: the boy gave Mary a book
-A NP0 -AH V -AH NP1 NP2 -A
EX: the boy gave a book to Mary
-A NP0 -AH V -AH NP2 P1 NP1 -A

WH0 V NP1 NP2 ?                       ## Who gave Mary the book?
WH0 V NP2 P1 NP1 ?                    ## who gave the book to Mary?
WH2 NP0 V P1 NP1 ?                    ## what did the boy give to Mary?
P1 WH1 NP0 V NP2 ?                    ## to whom did the boy give a book?
WH1 NP0 V NP2 P1 ?                    ## who did the boy give a book to?
WH2 NP0 V NP1 ?                       ## what will the boy give Mary?
```

NP1 P1 RELM NP0 -AH V -AH NP2 –A ## the girl to whom the boy gave a book

NP1 REL NP0 -AH V -AH NP2 P1 -A ## the girl who the boy gave a book to

NP1 NP0 -AH V -AH NP2 P1 -A ## the girl the boy gave a book to

NP0 REL -AH V -AH NP1 NP2 -A ## the boy who gave Mary the book

NP0 REL -AH V -AH NP2 to NP1 -A ## the boy who gave the book to Mary

NP1 REL NP0 -AH V -AH NP2 P1 -A ## Mary, who the boy gave the book to

NP1 P1 REL NP0 -AH V -AH NP2 -A ## Mary, to whom the boy gave the book

NP2 REL NP0 -AH V -AH NP1 -A ## The book which the boy gave Mary

NP2 REL NP0 -AH V -AH P1 NP1 -A ## The book which the boy gave to Mary

-A NP2 -AH V(Passive) -AH NP1 BY NP0 -A

the book was given Mary by the boy

-A NP2 -AH V(Passive) -AH P1 NP1 BY NP0 -A

the book was given to Mary by the boy

BY WH0 NP1 V(Passive) NP2 ?

By Whom was MARY GIVEN THE BOOK?

WH0 NP1 V(Passive) NP2 BY ?

who was Mary given the book by?

WH1 NP2 V(Passive) P1 BY NP0 ?

who was the book given to by the boy?

P1 WH1 NP2 V(Passive) BY NP0 ?

to whom was the book given by the boy?

WH2 V(Passive) NP1 BY NP0 ?

what was given Mary by the boy?

WH2 V(Passive) P1 NP1 BY NP0 ?

what was given to Mary by the boy?

WH2 V(Passive) BY NP0 P1 NP1 ?

what was given by the boy to Mary?

-A NP0 BY RELM NP1 -AH V(Passive) -AH NP2 -A

the boy, by whom Mary was given the book

-A NP0 BY RELM NP2 -AH V(Passive) -AH P1 NP1 -A

the boy, by whom the book was given to Mary

-A NP1 REL NP2 -AH V(Passive) -AH P1 BY NP0 -A

Mary, who the book was given to by the boy

-A NP1 P1 RELM NP2 -AH V(Passive) -AH BY NP0 -A

Mary, to whom the book was given by the boy

-A NP2 REL -AH V(Passive) -AH NP1 BY NP0 -A

the book, which was given Mary by the boy

-A NP2 REL -AH V(Passive) -AH P1 NP1 BY NP0 -A

the book, which was given to Mary by the boy

FRAME 5

EX: John put the book on the table

-A NP0 -AH V -AH NP1 P1 NP2 -A

WH0 V NP1 P1 NP2 ? ## Who put the book on the table?

WH1 NP0 V P1 NP2 ? ## What did John put on the table?

WH2 NP0 V NP1 ? ## Where did John put the book?

P1 WH2 NP0 V NP1 ? ## on what did John put the book?

-A NP2 P1 RELM NP0 -AH V -AH NP1 -A ## the table on which John put the book

-A NP2 REL -A NP0 -AH V -AH NP1 P1

the table which John put the book on

-A NP2 NP0 -AH V -AH NP1 P1 -A

the table John put the book on

-A NP1 REL -AH NP0 -AH V -AH P1 NP2 -A

the book which John put on the table

-A NP0 REL -AH V -AH NP1 P1 NP2 -A

John, who put the book on the table
-A NP1 -AH V(Passive) -AH P1 NP2 BY NP0 -A
the book was put on the table by John
BY WH0 NP1 V(Passive) P1 NP2 ?
By whom was the book put on the table?
WH0 NP1 V(Passive) P1 NP2 BY ?
who was the book put on the table by?
P1 WH2 NP1 V(Passive) BY NP0 ?
on what was the book put by John?
WH2 NP1 V(Passive) BY NP0 ?
where was the book put by John?
WH1 V(Passive) P1 NP2 BY NP0 ?
what was put on the table by John?
WH1 BY NP0 V(Passive) P1 NP2 ?
what was by John put on the table?
-A NP1 REL -AH V(Passive) -AH P1 NP2 BY NP0 -A
the book, which was put on the table by John
-A NP2 P1 REL NP1 -AH V(Passive) -AH BY NP0 -A
the table, on which the book was put by John
-A NP0 BY RELM NP1 -AH V(Passive) -AH P1 NP2 -A
John, by whom the book was put on the table

FRAME 6

EX: the boy talks to the girl
-A NP0 -AH V -AH P1 NP1 -A

WH0 V P1 NP1 ? ## who talks to the girl?
P1 WH1 NP0 V ? ## to whom does the boy talk?
WH1 NP0 V P ?

who does the boy talk to?

-A NP1 REL NP0 -AH V -AH P1 -A

the girl who the boy talks to

-A NP1 NP0 -AH V -AH P1 -A

the girl the boy talks to

-A NP0 REL -AH V -AH P1 NP1 -A

the boy who talks to the girl

-A NP1 V(Passive) P1 BY NP0

the girl was talked to by the boy

BY WH0 NP1 V(Passive) P1 ?

by whom was the girl talked to?

WH0 NP1 V(Passive) P1 BY ?

who was the girl talked to by?

WH1 V(Passive) P1 BY NP0 ?

who was talked to by the boy?

-A NP1 REL -AH V(Passive) -AH P1 BY NP0 -A

the girl, who is talked to by the boy

-A NP1 REL BY NP0 -AH V(Passive) -AH P1 -A

the girl, who is by the boy talked to

-A NP0 BY RELM NP1 -AH V -AH P1 -A

the boy, by whom the girl is talked to

-A NP0 REL NP1 -AH V(Passive) -AH P1 BY -A

the boy, who the girl is talked to by

FRAME 7

EX: John looked up the answer

-A NP0 -AH V -AH P1 NP1 -A

-A NP0 -AH V -AH NP1 P1 -A

John looked the answer up

WH0 V P1 NP1 ?

Who looked up the answer?

WH0 V NP1 P1 ?

Who looked the answer up?

WH1 NP0 V P1 ?

What did John look up?

-A NP0 REL -AH V -AH P1 NP1 -A

John, who looked up the answer

-A NP0 REL -AH V -AH NP1 P1 -A

John, who looked the answer up

-A NP1 REL NP0 -AH V -AH P1 -A

the answer, which John looked up

-A NP1 -AH V(Passive) -AH P1 BY NP0 -A

the answer was looked up by John.

BY WH0 NP1 V(Passive) P1 ?

By whom was the answer looked up?

WH0 NP1 V(Passive) P1 BY ?

who was the answer looked up by?

WH1 V(Passive) P1 BY NP0 ?

What was looked up by John?

-A NP1 REL -AH V(Passive) -AH P1 BY NP0 -A

the answer, which was looked up by John

-A NP1 REL BY NP0 -AH V(Passive) -AH P1

the answer, which was by John looked up

-A NP0 BY RELM NP1 -AH V(Passive) -AH P1

John, by whom the answer was looked up

-A NP0 REL NP1 -AH V(Passive) -AH P1 BY -A

John, who the answer was looked up by

FRAME 8

EX: She is 10 feet tall.

NP0 V -A

V NP0 ?

(Who/How tall) is she?

NP0 REL V -A

She, who is 10 feet tall

FRAME 9

EX: John looks up to his brother

-A NP0 -AH V -AH P1 P2 NP1 -A

WH0 V P1 P2 NP1 ?

Who looks up to his brother?

WH1 NP0 V P1 P2 ?

who does John look up to?

-A NP1 REL NP0 -AH V -AH P1 P2 -A

the one who John looks up to

-A NP1 REL NP0 -AH V -AH P1 P2 -A

the one John looks up to

-A NP0 REL -AH V -AH P1 P2 NP1 -A

John, who looks up to his brother

-A NP1 -AH V(Passive) -AH P1 P2 BY NP0 -A

his brother is looked up to by John

WH1 V(Passive) P1 P2 BY NP0 ?

who is looked up to by John?

BY WH0 NP1 V(Passive) P1 P2 ?

by whom is his brother looked up to?

WH0 NP1 V(Passive) P1 P2 BY ?

who is his brother looked up to by?

-A NP1 REL -AH V(Passive) -AH P1 P2 BY NP0 -A

his brother, who is looked up to by John

-A NP0 BY RELM NP1 -AH V(Passive) -AH P1 P2 -A

John, by whom his brother is looked up to

-A NP0 BY REL NP1 -AH V(Passive) -AH P1 P2 -A

John, who his brother is looked up to by

FRAME 10

EX: Jean went to school with Scott

-A NP0 -AH V -AH P1 NP1 -A P2 NP2 -A

WH0 V P1 NP1 P2 NP2 ?	## Who went to school with Scott?
P1 WH1 NP0 V P1 NP2 ?	## To where did Jean go with Scott?
WH1 NP0 V P1 P2 NP2 ?	## Where did Jean go to with Scott?
P2 WH2 NP0 V P1 NP1 ?	## With whom did Jean go to school?
WH2 NP0 V P1 NP1 P2 ?	## Who did Jean go to school with?

-A NP0 REL -AH V -AH P1 NP1 -A P2 NP2 -A

Jean, who went to school with Scott

-A NP1 REL NP0 -AH V -AH P1 -A P2 NP2 -A

the school, which Jean went to with Scott

-A NP1 P1 REL NP0 -AH V -A P2 NP2

the school, to which Jean went with Scott

-A NP2 REL NP0 -AH V -AH P1 NP1 P2 -A

Scott, who Jean went to school with

-A NP2 P2 RELM NP0 -AH V -AH P1 NP1 -A

Scott, with whom Jean went to school

framemap1

```
%framemap1 = (
  "WH V" => "WH0 V",
  "WH V P" => "WH0 V P1",
  "WH V NP" => "WH0 V NP1",
  "WH NP V" => "WH1 NP0 V",
  "BY WH NP V(Passive)" => "BY WH0 NP1 V(Passive)",
  "WH NP V(Passive) BY" => "WH0 NP1 V(Passive) BY",
  "WH V(Passive) BY NP" => "WH1 V(Passive) BY NP0",
  "WH V NP NP" => "WH0 V NP1 NP2",
  "WH V NP P NP" => "WH0 V NP2 P1 NP1",
  "WH NP V P NP" => "WH2 NP0 V P1 NP1",
  "P WH NP V NP" => "P1 WH1 NP0 V NP2",
  "WH NP V NP P" => "WH1 NP0 V NP2 P1",
  "WH NP V NP" => "WH2 NP0 V NP1",
  "BY WH NP V(Passive) NP" => "BY WH0 NP1 V(Passive) NP2",
  "WH NP V(Passive) NP BY" => "WH0 NP1 V(Passive) NP2 BY",
  "WH NP V(Passive) P BY NP" => "WH1 NP2 V(Passive) P1 BY NP0",
  "P WH NP V(Passive) BY NP" => "P1 WH1 NP2 V(Passive) BY NP0",
  "WH V(Passive) NP BY NP" => "WH2 V(Passive) NP1 BY NP0",
  "WH V(Passive) P NP BY NP" => "WH2 V(Passive) P1 NP1 BY NP0",
  "WH V(Passive) BY NP P NP" => "WH2 V(Passive) BY NP0 P1 NP1",
  "WH V NP P NP" => "WH0 V NP1 P1 NP2",
  "WH NP V P NP" => "WH1 NP0 V P1 NP2",
  "P WH NP V NP" => "P1 WH2 NP0 V NP1",
  "BY WH NP V(Passive) P NP" => "BY WH0 NP1 V(Passive) P1 NP2",
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"WH NP V(Passive) P NP BY" => "WH0 NP1 V(Passive) P1 NP2 BY",

"P WH NP V(Passive) BY NP" => "P1 WH2 NP1 V(Passive) BY NP0",

"WH NP V(Passive) BY NP" => "WH2 NP1 V(Passive) BY NP0",

"WH V(Passive) P NP BY NP" => "WH1 V(Passive) P1 NP2 BY NP0",

"WH BY NP V(Passive) P NP" => "WH1 BY NP0 V(Passive) P1 NP2",

"WH V P NP" => "WH0 V P1 NP1",

"P WH NP V" => "P1 WH1 NP0 V",

"WH NP V P" => "WH1 NP0 V P",

"BY WH NP V(Passive) P" => "BY WH0 NP1 V(Passive) P1",

"WH NP V(Passive) P BY" => "WH0 NP1 V(Passive) P1 BY",

"WH V(Passive) P BY NP" => "WH1 V(Passive) P1 BY NP0",

"WH V P NP" => "WH0 V P1 NP1",

"WH V NP P" => "WH0 V NP1 P1",

"WH NP V P" => "WH1 NP0 V P1",

"BY WH NP V(Passive) P" => "BY WH0 NP1 V(Passive) P1",

"WH NP V(Passive) P BY" => "WH0 NP1 V(Passive) P1 BY",

"WH V(Passive) P BY NP" => "WH1 V(Passive) P1 BY NP0",

"V NP" => "V NP0",

"WH V P P NP" => "WH0 V P1 P2 NP1",

"WH NP V P P" => "WH1 NP0 V P1 P2",

"WH V(Passive) P P BY NP" => "WH1 V(Passive) P1 P2 BY NP0",

"BY WH NP V(Passive) P P" => "BY WH0 NP1 V(Passive) P1 P2",

"WH NP V(Passive) P P BY" => "WH0 NP1 V(Passive) P1 P2 BY",

"WH V P NP P NP" => "WH0 V P1 NP1 P2 NP2",

"P WH NP V P NP" => "P1 WH1 NP0 V P1 NP2",

"WH NP V P P NP" => "WH1 NP0 V P1 P2 NP2",

"P WH NP V P NP" => "P2 WH2 NP0 V P1 NP1",

"WH NP V P NP P" => "WH2 NP0 V P1 NP1 P2",

"NP V" => "NP0 V",

"NP REL V" => "NP0 REL V",

"NPO V(ing)" => "NPO V(ing)",

"NP V P" => "NP0 V P1",

"NP REL V P" => "NP0 REL V P1",

"NP V(ing) P" => "NP0 V(ing) P1",

"NP V NP" => "NP0 V NP1",

"NP REL NP V" => "NP1 REL NP0 V",

"NP NP V" => "NP1 NP0 V",

"NP V(PastP) BY NP" => "NP1 V(PastP) BY NP0",

"NP V(Passive) BY NP" => "NP1 V(Passive) BY NP0",

"NP REL NP V(Passive) BY" => "NP0 REL NP1 V(Passive) BY",

"NP NP V(Passive) BY" => "NP0 NP1 V(Passive) BY",

"NP BY RELM NP V(Passive)" => "NP0 BY RELM NP1 V(Passive)",

"NP REL V(Passive) BY NP" => "NP1 REL V(Passive) BY NP0",

"NP V NP NP" => "NP0 V NP1 NP2",

"NP V NP P NP" => "NP0 V NP2 P1 NP1",

"NP P RELM NP V NP" => "NP1 P1 RELM NP0 V NP2",

"NP REL NP V NP P" => "NP1 REL NP0 V NP2 P1",

"NP NP V NP P" => "NP1 NP0 V NP2 P1",

"NP REL V NP NP" => "NP0 REL V NP1 NP2",

"NP REL V NP to NP" => "NP0 REL V NP2 to NP1",

"NP REL NP V NP P" => "NP1 REL NP0 V NP2 P1",

"NP P REL NP V NP" => "NP1 P1 REL NP0 V NP2",

"NP REL NP V NP" => "NP2 REL NP0 V NP1",

"NP REL NP V P NP" => "NP2 REL NP0 V P1 NP1",

"NP V(Passive) NP BY NP" => "NP2 V(Passive) NP1 BY NP0",

"NP V(Passive) P NP BY NP" => "NP2 V(Passive) P1 NP1 BY NP0",

"NP BY RELM NP V(Passive) NP" => "NP0 BY RELM NP1 V(Passive) NP2",

"NP BY RELM NP V(Passive) P NP" => "NP0 BY RELM NP2 V(Passive) P1 NP1",

"NP REL NP V(Passive) P BY NP" => "NP1 REL NP2 V(Passive) P1 BY NP0",

"NP P RELM NP V(Passive) BY NP" => "NP1 P1 RELM NP2 V(Passive) BY NP0",

"NP REL V(Passive) NP BY NP" => "NP2 REL V(Passive) NP1 BY NP0",

"NP REL V(Passive) P NP BY NP" => "NP2 REL V(Passive) P1 NP1 BY NP0",

"NP V NP P NP" => "NP0 V NP1 P1 NP2",

"NP P RELM NP V NP" => "NP2 P1 RELM NP0 V NP1",

"NP REL NP V NP P" => "NP2 REL NP0 V NP1 P1",

"NP NP V NP P" => "NP2 NP0 V NP1 P1",

"NP REL NP V P NP" => "NP1 REL NP0 V P1 NP2",

"NP REL V NP P NP" => "NP0 REL V NP1 P1 NP2",

"NP V(Passive) P NP BY NP" => "NP1 V(Passive) P1 NP2 BY NP0",

"NP REL V(Passive) P NP BY NP" => "NP1 REL V(Passive) P1 NP2 BY NP0",

"NP P REL NP V(Passive) BY NP" => "NP2 P1 REL NP1 V(Passive) BY NP0",

"NP BY RELM NP V(Passive) P NP" => "NP0 BY RELM NP1 V(Passive) P1 NP2",

"NP V P NP" => "NP0 V P1 NP1",

"NP REL NP V P" => "NP1 REL NP0 V P1",

"NP NP V P" => "NP1 NP0 V P1",

"NP REL V P NP" => "NP0 REL V P1 NP1",

"NP V(Passive) P BY NP" => "NP1 V(Passive) P1 BY NP0",

"NP REL V(Passive) P BY NP" => "NP1 REL V(Passive) P1 BY NP0",

"NP REL BY NP V(Passive) P" => "NP1 REL BY NP0 V(Passive) P1",

"NP BY RELM NP V P" => "NP0 BY RELM NP1 V P1",

"NP REL NP V(Passive) P BY" => "NP0 REL NP1 V(Passive) P1 BY",

"NP V P NP" => "NP0 V P1 NP1",

"NP V NP P" => "NP0 V NP1 P1",

"NP REL V P NP" => "NP0 REL V P1 NP1",

"NP REL V NP P" => "NP0 REL V NP1 P1",

"NP REL NP V P" => "NP1 REL NP0 V P1",

"NP V(Passive) P BY NP" => "NP1 V(Passive) P1 BY NP0",

"NP REL V(Passive) P BY NP" => "NP1 REL V(Passive) P1 BY NP0",

"NP REL BY NP V(Passive) P" => "NP1 REL BY NP0 V(Passive) P1",

"NP BY RELM NP V(Passive) P" => "NP0 BY RELM NP1 V(Passive) P1",

"NP REL NP V(Passive) P BY" => "NP0 REL NP1 V(Passive) P1 BY",

"NP V" => "NP0 V",

"NP REL V" => "NP0 REL V",

"NP V P P NP" => "NP0 V P1 P2 NP1",

"NP REL NP V P P" => "NP1 REL NP0 V P1 P2",

"NP REL NP V P P" => "NP1 REL NP0 V P1 P2",

"NP REL V P P NP" => "NP0 REL V P1 P2 NP1",

"NP V(Passive) P P BY NP" => "NP1 V(Passive) P1 P2 BY NP0",

"NP REL V(Passive) P P BY NP" => "NP1 REL V(Passive) P1 P2 BY NP0",

"NP BY RELM NP V(Passive) P P" => "NP0 BY RELM NP1 V(Passive) P1 P2",

"NP BY REL NP V(Passive) P P" => "NP0 BY REL NP1 V(Passive) P1 P2",

"NP V P NP P NP" => "NP0 V P1 NP1 P2 NP2",

"NP REL V P NP P NP" => "NP0 REL V P1 NP1 P2 NP2",

"NP REL NP V P P NP" => "NP1 REL NP0 V P1 P2 NP2",

"NP P REL NP V P NP" => "NP1 P1 REL NP0 V P2 NP2",

"NP REL NP V P NP P" => "NP2 REL NP0 V P1 NP1 P2",

"NP P RELM NP V P NP" => "NP2 P2 RELM NP0 V P1 NP1",

);

framemap2

%framemap2 = (

"WH0 V" => "NP0 V;NP0 REL V;NPO V(ing)",

"WH0 V P1" => "NP0 V P1;NP0 REL V P1;NP0 V(ing) P1",

"WH0 V NP1" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"WH1 NP0 V" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"BY WH0 NP1 V(Passive)" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"WH0 NP1 V(Passive) BY" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"WH1 V(Passive) BY NP0" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"WH0 V NP1 NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH0 V NP2 P1 NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH2 NP0 V P1 NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"P1 WH1 NP0 V NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH1 NP0 V NP2 P1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2

V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH2 NP0 V NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"BY WH0 NP1 V(Passive) NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH0 NP1 V(Passive) NP2 BY" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH1 NP2 V(Passive) P1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0

V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"P1 WH1 NP2 V(Passive) BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH2 V(Passive) NP1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH2 V(Passive) P1 NP1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH2 V(Passive) BY NP0 P1 NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"WH0 V NP1 P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"WH1 NP0 V P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"P1 WH2 NP0 V NP1" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"BY WH0 NP1 V(Passive) P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"WH0 NP1 V(Passive) P1 NP2 BY" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive)

P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"P1 WH2 NP1 V(Passive) BY NP0" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"WH2 NP1 V(Passive) BY NP0" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"WH1 V(Passive) P1 NP2 BY NP0" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"WH1 BY NP0 V(Passive) P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"WH0 V P1 NP1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"P1 WH1 NP0 V" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"WH1 NP0 V P" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"BY WH0 NP1 V(Passive) P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH0 NP1 V(Passive) P1 BY" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH1 V(Passive) P1 BY NP0" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH0 V P1 NP1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH0 V NP1 P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH1 NP0 V P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"BY WH0 NP1 V(Passive) P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL

V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH0 NP1 V(Passive) P1 BY" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"WH1 V(Passive) P1 BY NP0" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"V NP0" => "NP0 V;NP0 REL V",

"WH0 V P1 P2 NP1" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"WH1 NP0 V P1 P2" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"WH1 V(Passive) P1 P2 BY NP0" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"BY WH0 NP1 V(Passive) P1 P2" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"WH0 NP1 V(Passive) P1 P2 BY" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1

REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"WH0 V P1 NP1 P2 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"P1 WH1 NP0 V P1 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"WH1 NP0 V P1 P2 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"P2 WH2 NP0 V P1 NP1" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"WH2 NP0 V P1 NP1 P2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"NP0 V" => "NP0 V;NP0 REL V;NPO V(ing)",

"NP0 REL V" => "NP0 V;NP0 REL V;NPO V(ing)",

"NPO V(ing)" => "NP0 V;NP0 REL V;NPO V(ing)",

"NP0 V P1" => "NP0 V P1;NP0 REL V P1;NP0 V(ing) P1",

"NP0 REL V P1" => "NP0 V P1;NP0 REL V P1;NP0 V(ing) P1",

"NP0 V(ing) P1" => "NP0 V P1;NP0 REL V P1;NP0 V(ing) P1",

"NP0 V NP1" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP1 REL NP0 V" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP1 NP0 V" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP1 V(PastP) BY NP0" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP1 V(Passive) BY NP0" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP0 REL NP1 V(Passive) BY" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP0 NP1 V(Passive) BY" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP0 BY RELM NP1 V(Passive)" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP1 REL V(Passive) BY NP0" => "NP0 V NP1;NP1 REL NP0 V;NP1 NP0 V;NP1 V(PastP) BY NP0;NP1 V(Passive) BY NP0;NP0 REL NP1 V(Passive) BY;NP0 NP1 V(Passive) BY;NP0 BY RELM NP1 V(Passive);NP1 REL V(Passive) BY NP0",

"NP0 V NP1 NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP0 V NP2 P1 NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 P1 RELM NP0 V NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 REL NP0 V NP2 P1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 NP0 V NP2 P1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2

V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP0 REL V NP1 NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP0 REL V NP2 to NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 REL NP0 V NP2 P1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 P1 REL NP0 V NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1

NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP2 REL NP0 V NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP2 REL NP0 V P1 NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP2 V(Passive) NP1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2

V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP2 V(Passive) P1 NP1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP0 BY RELM NP1 V(Passive) NP2" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP0 BY RELM NP2 V(Passive) P1 NP1" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 REL NP2 V(Passive) P1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0

V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP1 P1 RELM NP2 V(Passive) BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP2 REL V(Passive) NP1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP2 REL V(Passive) P1 NP1 BY NP0" => "NP0 V NP1 NP2;NP0 V NP2 P1 NP1;NP1 P1 RELM NP0 V NP2;NP1 REL NP0 V NP2 P1;NP1 NP0 V NP2 P1;NP0 REL V NP1 NP2;NP0 REL V NP2 to NP1;NP1 REL NP0 V NP2 P1;NP1 P1 REL NP0 V NP2;NP2 REL NP0 V NP1;NP2 REL NP0 V P1 NP1;NP2 V(Passive) NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0;NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP2 V(Passive) P1 NP1;NP1 REL NP2 V(Passive) P1 BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0;NP2 REL V(Passive) NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0",

"NP0 V NP1 P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP2 P1 RELM NP0 V NP1" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP2 REL NP0 V NP1 P1" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP2 NP0 V NP1 P1" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP1 REL NP0 V P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP0 REL V NP1 P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP1 V(Passive) P1 NP2 BY NP0" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP1 REL V(Passive) P1 NP2 BY NP0" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP2 P1 REL NP1 V(Passive) BY NP0" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP0 BY RELM NP1 V(Passive) P1 NP2" => "NP0 V NP1 P1 NP2;NP2 P1 RELM NP0 V NP1;NP2 REL NP0 V NP1 P1;NP2 NP0 V NP1 P1;NP1 REL NP0 V P1 NP2;NP0 REL V NP1 P1 NP2;NP1 V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0;NP0 BY RELM NP1 V(Passive) P1 NP2;",

"NP0 V P1 NP1" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 REL NP0 V P1" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 NP0 V P1" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 REL V P1 NP1" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 V(Passive) P1 BY NP0" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 REL V(Passive) P1 BY NP0" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 REL BY NP0 V(Passive) P1" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 BY RELM NP1 V P1" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 REL NP1 V(Passive) P1 BY" => "NP0 V P1 NP1;NP1 REL NP0 V P1;NP1 NP0 V P1;NP0 REL V P1 NP1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 V P1 NP1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 V NP1 P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 REL V P1 NP1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 REL V NP1 P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 REL NP0 V P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 V(Passive) P1 BY NP0" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 REL V(Passive) P1 BY NP0" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP1 REL BY NP0 V(Passive) P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 BY RELM NP1 V(Passive) P1" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 REL NP1 V(Passive) P1 BY" => "NP0 V P1 NP1;NP0 V NP1 P1;NP0 REL V P1 NP1;NP0 REL V NP1 P1;NP1 REL NP0 V P1;NP1 V(Passive) P1 BY NP0;NP1 REL V(Passive) P1 BY NP0;NP1 REL BY NP0 V(Passive) P1;NP0 BY RELM NP1 V(Passive) P1;NP0 REL NP1 V(Passive) P1 BY",

"NP0 V" => "NP0 V;NP0 REL V",

"NP0 REL V" => "NP0 V;NP0 REL V",

"NP0 V P1 P2 NP1" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP1 REL NP0 V P1 P2" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP1 REL NP0 V P1 P2" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP0 REL V P1 P2 NP1" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP1 V(Passive) P1 P2 BY NP0" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP1 REL V(Passive) P1 P2 BY NP0" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY

NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP0 BY RELM NP1 V(Passive) P1 P2" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP0 BY REL NP1 V(Passive) P1 P2" => "NP0 V P1 P2 NP1;NP1 REL NP0 V P1 P2;NP1 REL NP0 V P1 P2;NP0 REL V P1 P2 NP1;NP1 V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0;NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) P1 P2",

"NP0 V P1 NP1 P2 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"NP0 REL V P1 NP1 P2 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"NP1 REL NP0 V P1 P2 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"NP1 P1 REL NP0 V P2 NP2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"NP2 REL NP0 V P1 NP1 P2" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1",

"NP2 P2 RELM NP0 V P1 NP1" => "NP0 V P1 NP1 P2 NP2;NP0 REL V P1 NP1 P2 NP2;NP1 REL NP0 V P1 P2 NP2;NP1 P1 REL NP0 V P2 NP2;NP2 REL NP0 V P1 NP1 P2;NP2 P2 RELM NP0 V P1 NP1"

);

adjframes

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%adjframes = (
"NP0 V" => "-A NP0 V;NP0 -AH V;NP0 V -A",
"NP0 REL V" => "NP0 REL -AH V;NP0 REL V -A",
"NPO V(ing)" => "NPO V(ing) -A",
"NP0 V P1" => "-A NP0 V P1;NP0 V -AH P1;NP0 V P1 -A",
"NP0 REL V P1" => "NP0 REL -AH V P1;NP0 REL V P1 -A",
"NP0 V(ing) P1" => "NP0 -AH V(ing) P1;NP0 V(ing) P1 -A",
"NP0 V NP1" => "-A NP0 V NP1;NP0 -AH V NP1;NP0 V -AH NP1;NP0 V NP1 -A",
"NP1 REL NP0 V" => "NP1 REL NP0 -AH V;NP1 REL NP0 V -A",
"NP1 NP0 V" => "NP1 NP0 -AH V;NP1 NP0 V -A",
"NP1 V(PastP) BY NP0" => "NP1 V(PastP) -A BY NP0;NP1 V(PastP) BY NP0 -A",

"NP1 V(Passive) BY NP0" => "NP1 V(Passive) -A BY NP0;NP1 V(Passive) BY NP0 -A",
"NP0 REL NP1 V(Passive) BY" => "NP0 REL -A NP1 V(Passive) BY;NP0 REL NP1 V(Passive) BY -A",
"NP0 NP1 V(Passive) BY" => "NP0 NP1 V(Passive) BY -A",
"NP0 BY RELM NP1 V(Passive)" => "NP0 BY RELM NP1 V(Passive) -A",
"NP1 REL V(Passive) BY NP0" => "NP1 REL -AH V(Passive) BY NP0;NP1 REL V(Passive) BY NP0 -A",
"NP0 V NP1 NP2" => "-A NP0 V NP1 NP2;NP0 -AH V NP1 NP2;NP0 V -AH NP1 NP2;NP0 V NP1 NP2 -A",
"NP0 V NP2 P1 NP1" => "-A NP0 V NP2 P1 NP1;NP0 -AH V NP2 P1 NP1;NP0 V -AH NP2 P1 NP1;NP0 V NP2 P1 NP1 -A",
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"NP1 P1 RELM NP0 V NP2" => "NP1 P1 RELM NP0 -AH V NP2;NP1 P1 RELM NP0 V -AH NP2;NP1 P1 RELM NP0 V NP2 -A",

"NP1 REL NP0 V NP2 P1" => "NP1 REL NP0 -AH V NP2 P1;NP1 REL NP0 V -AH NP2 P1;NP1 REL NP0 V NP2 P1 -A",

"NP1 NP0 V NP2 P1" => "NP1 NP0 -AH V NP2 P1;NP1 NP0 V -AH NP2 P1;NP1 NP0 V NP2 P1 -A",

"NP0 REL V NP1 NP2" => "NP0 REL -AH V NP1 NP2;NP0 REL V -AH NP1 NP2;NP0 REL V NP1 NP2 -A",

"NP0 REL V NP2 to NP1" => "NP0 REL -AH V NP2 to NP1;NP0 REL V -AH NP2 to NP1;NP0 REL V NP2 to NP1 -A",

"NP1 REL NP0 V NP2 P1" => "NP1 REL NP0 -AH V NP2 P1;NP1 REL NP0 V -AH NP2 P1;NP1 REL NP0 V NP2 P1 -A",

"NP1 P1 REL NP0 V NP2" => "NP1 P1 REL NP0 -AH V NP2;NP1 P1 REL NP0 V -AH NP2;NP1 P1 REL NP0 V NP2 -A",

"NP2 REL NP0 V NP1" => "NP2 REL NP0 -AH V NP1;NP2 REL NP0 V -AH NP1;NP2 REL NP0 V NP1 -A",

"NP2 REL NP0 V P1 NP1" => "NP2 REL NP0 -AH V P1 NP1;NP2 REL NP0 V -AH P1 NP1;NP2 REL NP0 V P1 NP1 -A",

"NP2 V(Passive) NP1 BY NP0" => "-A NP2 V(Passive) NP1 BY NP0;NP2 -AH V(Passive) NP1 BY NP0;NP2 V(Passive) -AH NP1 BY NP0;NP2 V(Passive) NP1 BY NP0 -A",

"NP2 V(Passive) P1 NP1 BY NP0" => "-A NP2 V(Passive) P1 NP1 BY NP0;NP2 -AH V(Passive) P1 NP1 BY NP0;NP2 V(Passive) -AH P1 NP1 BY NP0;NP2 V(Passive) P1 NP1 BY NP0 -A",

"NP0 BY RELM NP1 V(Passive) NP2" => "-A NP0 BY RELM NP1 V(Passive) NP2;NP0 BY RELM NP1 -AH V(Passive) NP2;NP0 BY RELM NP1 V(Passive) -AH NP2;NP0 BY RELM NP1 V(Passive) NP2 -A",

"NP0 BY RELM NP2 V(Passive) P1 NP1" => "-A NP0 BY RELM NP2 V(Passive) P1 NP1;NP0 BY RELM NP2 -AH V(Passive) P1 NP1;NP0 BY RELM NP2 V(Passive) -AH P1 NP1;NP0 BY RELM NP2 V(Passive) P1 NP1 -A",

"NP1 REL NP2 V(Passive) P1 BY NP0" => "-A NP1 REL NP2 V(Passive) P1 BY NP0;NP1 REL NP2 -AH V(Passive) P1 BY NP0;NP1 REL NP2 V(Passive) -AH P1 BY NP0;NP1 REL NP2 V(Passive) P1 BY NP0 -A",

"NP1 P1 RELM NP2 V(Passive) BY NP0" => "-A NP1 P1 RELM NP2 V(Passive) BY NP0;NP1 P1 RELM NP2 -AH V(Passive) BY NP0;NP1 P1 RELM NP2 V(Passive) -AH BY NP0;NP1 P1 RELM NP2 V(Passive) BY NP0 -A",

"NP2 REL V(Passive) NP1 BY NP0" => "-A NP2 REL V(Passive) NP1 BY NP0;NP2 REL -AH V(Passive) NP1 BY NP0;NP2 REL V(Passive) -AH NP1 BY NP0;NP2 REL V(Passive) NP1 BY NP0 -A",

"NP2 REL V(Passive) P1 NP1 BY NP0" => "-A NP2 REL V(Passive) P1 NP1 BY NP0;NP2 REL -AH V(Passive) P1 NP1 BY NP0;NP2 REL V(Passive) -AH P1 NP1 BY NP0;NP2 REL V(Passive) P1 NP1 BY NP0 -A",

"NP0 V NP1 P1 NP2" => "-A NP0 V NP1 P1 NP2;NP0 -AH V NP1 P1 NP2;NP0 V -AH NP1 P1 NP2;NP0 V NP1 P1 NP2 -A",

"NP2 P1 RELM NP0 V NP1" => "-A NP2 P1 RELM NP0 V NP1;NP2 P1 RELM NP0 -AH V NP1;NP2 P1 RELM NP0 V -AH NP1;NP2 P1 RELM NP0 V NP1 -A",

"NP2 REL NP0 V NP1 P1" => "-A NP2 REL NP0 V NP1 P1;NP2 REL -A NP0 V NP1 P1;NP2 REL NP0 -AH V NP1 P1;NP2 REL NP0 V -AH NP1 P1",

"NP2 NP0 V NP1 P1" => "-A NP2 NP0 V NP1 P1;NP2 NP0 -AH V NP1 P1;NP2 NP0 V -AH NP1 P1;NP2 NP0 V NP1 P1 -A",

"NP1 REL NP0 V P1 NP2" => "-A NP1 REL NP0 V P1 NP2;NP1 REL -AH NP0 V P1 NP2;NP1 REL NP0 -AH V P1 NP2;NP1 REL NP0 V -AH P1 NP2;NP1 REL NP0 V P1 NP2 -A",

"NP0 REL V NP1 P1 NP2" => "-A NP0 REL V NP1 P1 NP2;NP0 REL -AH V NP1 P1 NP2;NP0 REL V -AH NP1 P1 NP2;NP0 REL V NP1 P1 NP2 -A",

"NP1 V(Passive) P1 NP2 BY NP0" => "-A NP1 V(Passive) P1 NP2 BY NP0;NP1 -AH V(Passive) P1 NP2 BY NP0;NP1 V(Passive) -AH P1 NP2 BY NP0;NP1 V(Passive) P1 NP2 BY NP0 -A",

"NP1 REL V(Passive) P1 NP2 BY NP0" => "-A NP1 REL V(Passive) P1 NP2 BY NP0;NP1 REL -AH V(Passive) P1 NP2 BY NP0;NP1 REL V(Passive) -AH P1 NP2 BY NP0;NP1 REL V(Passive) P1 NP2 BY NP0 -A",

"NP2 P1 REL NP1 V(Passive) BY NP0" => "-A NP2 P1 REL NP1 V(Passive) BY NP0;NP2 P1 REL NP1 -AH V(Passive) BY NP0;NP2 P1 REL NP1 V(Passive) -AH BY NP0;NP2 P1 REL NP1 V(Passive) BY NP0 -A",

"NP0 BY RELM NP1 V(Passive) P1 NP2" => "-A NP0 BY RELM NP1 V(Passive) P1 NP2;NP0 BY RELM NP1 -AH V(Passive) P1 NP2;NP0 BY RELM NP1 V(Passive) -AH P1 NP2;NP0 BY RELM NP1 V(Passive) P1 NP2 -A",

"" => "EMPTY",

"NP0 V P1 NP1" => "-A NP0 V P1 NP1;NP0 -AH V P1 NP1;NP0 V -AH P1 NP1;NP0 V P1 NP1 -A",

"NP1 REL NP0 V P1" => "-A NP1 REL NP0 V P1;NP1 REL NP0 -AH V P1;NP1 REL NP0 V -AH P1;NP1 REL NP0 V P1 -A",

"NP1 NP0 V P1" => "-A NP1 NP0 V P1;NP1 NP0 -AH V P1;NP1 NP0 V -AH P1;NP1 NP0 V P1 -A",

"NP0 REL V P1 NP1" => "-A NP0 REL V P1 NP1;NP0 REL -AH V P1 NP1;NP0 REL V -AH P1 NP1;NP0 REL V P1 NP1 -A",

"NP1 V(Passive) P1 BY NP0" => "-A NP1 V(Passive) P1 BY NP0",

"NP1 REL V(Passive) P1 BY NP0" => "-A NP1 REL V(Passive) P1 BY NP0;NP1 REL -AH V(Passive) P1 BY NP0;NP1 REL V(Passive) -AH P1 BY NP0;NP1 REL V(Passive) P1 BY NP0 -A",

"NP1 REL BY NP0 V(Passive) P1" => "-A NP1 REL BY NP0 V(Passive) P1;NP1 REL BY NP0 -AH V(Passive) P1;NP1 REL BY NP0 V(Passive) -AH P1;NP1 REL BY NP0 V(Passive) P1 -A",

"NP0 BY RELM NP1 V P1" => "-A NP0 BY RELM NP1 V P1;NP0 BY RELM NP1 -AH V P1;NP0 BY RELM NP1 V -AH P1;NP0 BY RELM NP1 V P1 -A",

"NP0 REL NP1 V(Passive) P1 BY" => "-A NP0 REL NP1 V(Passive) P1 BY;NP0 REL NP1 -AH V(Passive) P1 BY;NP0 REL NP1 V(Passive) -AH P1 BY;NP0 REL NP1 V(Passive) P1 BY -A",

"NP0 V P1 NP1" => "-A NP0 V P1 NP1;NP0 -AH V P1 NP1;NP0 V -AH P1 NP1;NP0 V P1 NP1 -A",

"NP0 V NP1 P1" => "-A NP0 V NP1 P1;NP0 -AH V NP1 P1;NP0 V -AH NP1 P1;NP0 V NP1 P1 -A",

"NP0 REL V P1 NP1" => "-A NP0 REL V P1 NP1;NP0 REL -AH V P1 NP1;NP0 REL V -AH P1 NP1;NP0 REL V P1 NP1 -A",

"NP0 REL V NP1 P1" => "-A NP0 REL V NP1 P1;NP0 REL -AH V NP1 P1;NP0 REL V -AH NP1 P1;NP0 REL V NP1 P1 -A",

"NP1 REL NP0 V P1" => "-A NP1 REL NP0 V P1;NP1 REL NP0 -AH V P1;NP1 REL NP0 V -AH P1;NP1 REL NP0 V P1 -A",

"NP1 V(Passive) P1 BY NP0" => "-A NP1 V(Passive) P1 BY NP0;NP1 -AH V(Passive) P1 BY NP0;NP1 V(Passive) -AH P1 BY NP0;NP1 V(Passive) P1 BY NP0 -A",

"NP1 REL V(Passive) P1 BY NP0" => "-A NP1 REL V(Passive) P1 BY NP0;NP1 REL -AH V(Passive) P1 BY NP0;NP1 REL V(Passive) -AH P1 BY NP0;NP1 REL V(Passive) P1 BY NP0 -A",

"NP1 REL BY NP0 V(Passive) P1" => "-A NP1 REL BY NP0 V(Passive) P1;NP1 REL BY NP0 -AH V(Passive) P1;NP1 REL BY NP0 V(Passive) -AH P1",

"NP0 BY RELM NP1 V(Passive) P1" => "-A NP0 BY RELM NP1 V(Passive) P1;NP0 BY RELM NP1 -AH V(Passive) P1;NP0 BY RELM NP1 V(Passive) -AH P1",

"NP0 REL NP1 V(Passive) P1 BY" => "-A NP0 REL NP1 V(Passive) P1 BY;NP0 REL NP1 -AH V(Passive) P1 BY;NP0 REL NP1 V(Passive) -AH P1 BY;NP0 REL NP1 V(Passive) P1 BY -A",

"NP0 V" => "NP0 V -A",

"NP0 REL V" => "NP0 REL V -A",

"NP0 V P1 P2 NP1" => "-A NP0 V P1 P2 NP1;NP0 -AH V P1 P2 NP1;NP0 V -AH P1 P2 NP1;NP0 V P1 P2 NP1 -A",

"NP1 REL NP0 V P1 P2" => "-A NP1 REL NP0 V P1 P2;NP1 REL NP0 -AH V P1 P2;NP1 REL NP0 V -AH P1 P2;NP1 REL NP0 V P1 P2 -A",

"NP1 REL NP0 V P1 P2" => "-A NP1 REL NP0 V P1 P2;NP1 REL NP0 -AH V P1 P2;NP1 REL NP0 V -AH P1 P2;NP1 REL NP0 V P1 P2 -A",

"NP0 REL V P1 P2 NP1" => "-A NP0 REL V P1 P2 NP1;NP0 REL -AH V P1 P2 NP1;NP0 REL V -AH P1 P2 NP1;NP0 REL V P1 P2 NP1 -A",

"NP1 V(Passive) P1 P2 BY NP0" => "-A NP1 V(Passive) P1 P2 BY NP0;NP1 -AH V(Passive) P1 P2 BY NP0;NP1 V(Passive) -AH P1 P2 BY NP0;NP1 V(Passive) P1 P2 BY NP0 -A",

"NP1 REL V(Passive) P1 P2 BY NP0" => "-A NP1 REL V(Passive) P1 P2 BY NP0;NP1 REL -AH V(Passive) P1 P2 BY NP0;NP1 REL V(Passive) -AH P1 P2 BY NP0;NP1 REL V(Passive) P1 P2 BY NP0 -A",

"NP0 BY RELM NP1 V(Passive) P1 P2" => "-A NP0 BY RELM NP1 V(Passive) P1 P2;NP0 BY RELM NP1 -AH V(Passive) P1 P2;NP0 BY RELM NP1 V(Passive) -AH P1 P2;NP0 BY RELM NP1 V(Passive) P1 P2 -A",

"NP0 BY REL NP1 V(Passive) P1 P2" => "-A NP0 BY REL NP1 V(Passive) P1 P2;NP0 BY REL NP1 -AH V(Passive) P1 P2;NP0 BY REL NP1 V(Passive) -AH P1 P2;NP0 BY REL NP1 V(Passive) P1 P2 -A",

"NP0 V P1 NP1 P2 NP2" => "-A NP0 V P1 NP1 P2 NP2;NP0 -AH V P1 NP1 P2 NP2;NP0 V -AH P1 NP1 P2 NP2;NP0 V P1 NP1 -A P2 NP2;NP0 V P1 NP1 P2 NP2 -A",

"NP0 REL V P1 NP1 P2 NP2" => "-A NP0 REL V P1 NP1 P2 NP2;NP0 REL -AH V P1 NP1 P2 NP2;NP0 REL V -AH P1 NP1 P2 NP2;NP0 REL V P1 NP1 -A P2 NP2;NP0 REL V P1 NP1 P2 NP2 -A",

"NP1 REL NP0 V P1 P2 NP2" => "-A NP1 REL NP0 V P1 P2 NP2;NP1 REL NP0 -AH V P1 P2 NP2;NP1 REL NP0 V -AH P1 P2 NP2;NP1 REL NP0 V P1 -A P2 NP2;NP1 REL NP0 V P1 P2 NP2 -A",

"NP1 P1 REL NP0 V P2 NP2" => "-A NP1 P1 REL NP0 V P2 NP2;NP1 P1 REL NP0 -AH V P2 NP2;NP1 P1 REL NP0 V -A P2 NP2",

"NP2 REL NP0 V P1 NP1 P2" => "-A NP2 REL NP0 V P1 NP1 P2;NP2 REL NP0 -AH V P1 NP1 P2;NP2 REL NP0 V -AH P1 NP1 P2;NP2 REL NP0 V P1 NP1 P2 -A",

"NP2 P2 RELM NP0 V P1 NP1" => "-A NP2 P2 RELM NP0 V P1 NP1;NP2 P2 RELM NP0 -AH V P1 NP1;NP2 P2 RELM NP0 V -AH P1 NP1;NP2 P2 RELM NP0 V P1 NP1 -A"

);

While the invention has been described and illustrated in connection with certain preferred embodiments, many variations and modifications as will be evident to those skilled in the art may be made therein without departing from the spirit of the invention, and the invention is thus not to be limited to the precise details set forth above as such variations and modifications are intended to be included within the scope of the invention. It is intended that the specification and examples be considered as exemplary only, with the true scope and spirit of the invention being indicated by the following claims.

What is claimed is: